

### **Improving Milling and End Use Quality of Wheat**

**Department of Plant Sciences and Plant Pathology, Montana State University,  
Bozeman**

Montana has a world-wide reputation for producing high quality, hard wheat. The goal of this project is to create useful new variation in genes that have large impacts upon milling and/or baking quality. Two genes that have major impacts on the amount and quality of flour are the *Puroindolines*, and *Glutenins*. The *Puroindoline* genes control most of the variation in grain texture. *Glutenin* genes produce proteins that are responsible for the strength, elasticity, and mixing characteristics of flour dough. These new variants will be evaluated to determine their effect on dough properties. The goal is that the new variants for these genes will expand the current genetic variation available for important milling, dough mixing and bread quality traits. The useful new variants will then be incorporated into new spring and winter wheat varieties with improved milling and end use quality for Montana growers.

### **Development of Bismuth-thiol Based Therapeutic Agents for Treating Chronic Wounds**

**Center for Biofilm Engineering, Montana State University, Bozeman**

Montana State University (MSU) will partner with Bozeman-based Microbion Corporation regarding research to advance the development of a topical, anti-infective, anti-biofilm drug formulation, for the treatment of chronic wounds. The project is a natural partnership between MSU's Center for Biofilm Engineering, an international leader in biofilm science and technology, and a local business that has licensed anti-infective chemistry known as bismuth-thiols. The type of wounds that would be specifically targeted by this technology include diabetic foot ulcers and venous leg ulcers, sores that are notoriously difficult to heal. Using biofilm systems developed at the Center for Biofilm Engineering, bismuth-thiols, alone and in combination with conventional antibiotics, will be evaluated for their ability to kill bacteria in biofilms and improve healing of injured skin cells grown in co-culture with bacterial biofilms. These data will facilitate the optimization of Microbion's formulation for topical treatment of chronic wounds and will aid Microbion in attracting venture capital funding to support the additional work needed to obtain FDA approval.

### **Heat Tolerant Spring Wheat for Montana**

**Department of Plant Sciences & Plant Pathology, Montana State University,  
Bozeman**

Years of market development and research has made hard red spring wheat produced in Montana a premium product in the international marketplace. The hard red spring wheat crop is threatened by high temperatures that impede the ability of the plant to produce plump seed, resulting in low yield and poor quality grain. Fortunately, recent work in molecular biology has allowed identification of genes that influence the ability of wheat to withstand high temperatures. The goal of this project is to use molecular techniques to rapidly develop heat-tolerant lines for testing in sites around Montana, including Havre,

Huntley, Kalispell, and Moccasin. A successful outcome will lead to the release of new heat tolerant spring wheat varieties for Montana agriculture.

**WiMAX-based Relay Node with Smart Adaptive Antennas for Mesh Networking**  
**Department of Computer Science, Montana State University, Bozeman**

The goal of this project is to develop a new radio node and network software infrastructure based on emerging WiMAX wireless standards that will leverage a compact, low-cost smart adaptive antenna system and new chip-scale radio technologies to provide robust and highly available long-range and high-speed wireless communications for rural and remote areas. The project team will be working with the Montana division of Advanced Acoustic Concepts Inc. (AAC), a company engaged in applying advanced wireless technologies to provide long-range, high-speed communication capability to remote sensors for government and commercial applications. This project will enable the creation of new functionalities that will expand the capabilities of WiMAX radio systems, opening new commercial market opportunities for AAC's Montana division in areas including offshore buoys, animal tracking, farming and agriculture, first responder rescue, mass transit broadband backbone and commercial shipping broadband backbones. The products developed in this project will also offer the potential to provide commercial Internet services for rural and remote areas where current approaches have not proven to be economically viable.

**Control of Microbial Processes for Enhanced Water Treatment Using Floating Island Treatment Systems**  
**Center for Biofilm Engineering, Montana State University, Bozeman**

The goal of this project is to conduct research on the dynamics of microbial communities occurring in engineered floating islands used for water treatment. These floating islands (trade marked Biohaven<sup>TM</sup>), which consist of a non-woven matrix made of 100% recycled plastic fabricated into floating mats, have been developed by Floating Island International LLC (FII), headquartered near Shepherd MT, and are moving rapidly toward full-scale commercialization. Previous research done in test ponds at FII's outdoor research facility has provided observations of the substantial disappearance of key waste water constituents such as organic carbon, ammonia, nitrate and phosphate in the presence of floating islands. The microbiological process research component for this project, which will be carried out the Center for Biofilm Engineering (CBE) at Montana State University, will provide fundamental understanding of the microbial processes at work during contaminant uptake. The CBE research will be carried out in collaboration with a field research program conducted by FII resulting in new and improved design and operation criteria for Biohaven<sup>TM</sup> floating islands. Also a hybrid wind-solar power generation system for use in remote locations will be developed as part of this project. The improved product design along with fundamental scientific validation of floating islands as an emerging technology for nutrient removal from waterways will greatly expand the market available for Biohaven<sup>TM</sup> floating island products.

**MEMS Variable Focus Lens: Technology Development for Commercial Applications in Medical Imaging and Consumer Electronics**  
**Montana Microfabrication Facility, Montana State University, Bozeman**

Dr. David Dickensheets, Associate Professor of Electrical and Computer Engineering at Montana State University, will collaborate with Dr. Peter Roos and Dr. Randy Riebel of Bridger Photonics, Inc. of Bozeman to develop new technology for electronic focus control for optical imaging devices. The technology is based on deformable mirrors made from a thin reflective membrane using MEMS techniques. The mirrors, which measure a few millimeters in diameter, can deform from a flat shape to a bowl shape under electronic control, which changes their optical focusing power. Lenses made using these mirrors could provide focus control or zoom capability without needing to mechanically move lenses in and out. Potential commercial applications include ultra-compact auto-focus or zoom lenses with no moving parts for cell phone cameras or medical imaging endoscopes.

**Research Support for Standardizing a Comprehensive Biofilm Efficacy Test System**  
**Center for Biofilm Engineering, Montana State University, Bozeman**

The Center for Biofilm Engineering at Montana State University (MSU) in collaboration with the Mechanical and Industrial Engineering Department of MSU and BioSurface Technologies, Inc, located in Bozeman, MT received funding to design, build and test a comprehensive biofilm efficacy test system that would enable laboratory personnel to more efficiently conduct biofilm efficacy testing. Biofilm is a self-organized, cooperative community of bacteria most often associated with a surface and embedded in a layer of slime. Biofilm adversely affects many different industries. For example, biofilm is known to contaminate distribution pipes and is associated with chronic infections. An absolute requirement for registering an “anti-biofilm” product or treatment with the US Environmental Protection Agency (EPA) or Food and Drug Administration (FDA), is that the product’s efficacy is tested according to a standard method. Biofilm methods are complicated. A review of current tools available for biofilm efficacy testing revealed the need for a laboratory tool that would enable laboratory researchers to more efficiently conduct biofilm efficacy experiments. A successful tool will enable researchers to manipulate several test surfaces simultaneously during biofilm efficacy testing and ultimately make the experiment easier to conduct. The final outcome of this project will be a research tool ready for commercialization and production that BioSurface will manufacture, market and sell.

**New Fluorescent Biosensors for Drug Discovery**  
**Montana Molecular, Bozeman**

Montana Molecular Inc. is developing molecular biosensors that enable drug discovery. Drugs work by targeting specific cellular activities within the body. Many of these activities cannot be detected using existing methods, representing a major obstacle to new drug discovery. The biosensors developed in this project will detect drug activity in living cells through a change in fluorescence, and will be used in automated high-throughput

drug discovery. This project has the potential to lead to new breakthroughs for treating diseases such as Alzheimer's, Parkinson's, cancer and stroke.

**Resource Assessment of Deep Coals in Eastern Montana: Potential Targets for Commercialization by In-Situ Gasification**  
**Montana Bureau of Mines and Geology, Billings**

Montana has more coal reserves than any other state, but many of Montana's coal beds lie deeper than 500 feet below the surface and are not mineable using surface-mining techniques. In-situ or underground gasification is a method of controlled burning of deep coal beds; the resulting gases are captured, processed into a useable synthetic gas, and fed into pipelines or converted to liquids. Successful in-situ gasification projects require detailed knowledge of the subsurface geology and hydrogeology, and this information is critical to potential developers and government agencies. This project is the important first step toward commercializing Montana's deep coal seams – identifying the location and extent of these resources, and assessing their suitability for emerging clean coal technologies such as underground gasification. Results from this project will provide a solid, geological basis from which to promote and manage the future development and utilization of these valuable energy resources.

**Development of Germination Techniques for *Carex*, *Scirpus*, and *Eleocharis* Species**  
**Great Bear Restoration, Hamilton**

Wetland plant materials are a highly specialized niche market of agricultural production. The plants are utilized in wetland mitigation, treatment wetland systems, erosion control and habitat development projects throughout the United States. Several wetland species, however, are difficult to grow with exacting germination requirements. Great Bear Restoration will develop new techniques for the production of these materials and will be marketing the plants to clients throughout the western states.

**Research and Commercialization of the SepticNET™ Nutrient Removal Technology**  
**Water & Environmental Technologies, PC, Butte**

Water & Environmental Technologies, PC will research, develop, and commercialize a superior nutrient elimination technology for individual on-site septic systems called the SepticNET™. The technology will outperform all existing competitive systems currently approved by the Montana DEQ or EPA by more than 300%, reducing total nitrogen concentrations below current levels that trigger regulatory action and below drinking water standards. The SepticNET™ system will be available for use with new home construction or as an upgrade to existing septic systems. The SepticNET™ will be the only system available capable of removing total nitrogen and phosphorus to levels low enough to meet increased environmental regulatory restrictions for individual, on-site septic systems and reduce permitting time. Current development restrictions have been placed on numerous proposed housing developments throughout Montana due to increased nutrients found in drinking water wells and surface water bodies. Because of the extreme number of lots currently affected by increased nutrient levels and the ever

increasing desire of residents to live in rural areas, the commercialization potential for the SepticNET™ is not only very high, but essential to future residential development in Montana. The SepticNET™ system will provide the solution to rural and suburban development by allowing communities across Montana to meet future housing demands while minimizing impacts to ground water and surface water resources

**Development and Commercialization of a Biomass Based Photobioreactor for CO<sub>2</sub> Sequestration with Applications in Clean Coal Energy Production**  
**Sustainable Systems LLC, Missoula**

To reduce anthropogenic contributions of CO<sub>2</sub> to our atmosphere, Sustainable Systems Inc. is pursuing the development and commercialization of a novel photobioreactor as a CO<sub>2</sub> sequestration device for coal liquefaction and coal fired power plants. . The bioreactor passively collects sunlight and CO<sub>2</sub> for the cultivation of algae. The resulting biomass can then be used as a raw material for fuels and an array of specialty products. This technology has the potential to propel Montana to the forefront of innovative solutions to managing CO<sub>2</sub> emissions. Sustainable System's objective is to build and demonstrate a pilot scale photobioreactor utilizing an industrial CO<sub>2</sub> source, and to collect additional data for design optimization before deployment of commercial-scale systems.

**A Frequency Agile Digital Beamforming Antenna for WiMAX Radio Wireless Networks**  
**Department of Electrical & Computer Engineering, Montana State University, Bozeman**

The goals of this project are to design and develop a frequency agile digital beamforming antenna test bed that can dynamically select the appropriate spectrum beam form, and is able to communicate simultaneously with multiple users. The test bed will allow wireless experiments and characterization of various array algorithms under realistic channel conditions. This project explores the feasibility of implementing smart antennas in conjunction with cognitive radio technologies to create antenna array systems capable of reconfiguring their spatial and spectral receiving and transmitting characteristics in response to dynamic environmental demands. This novel antenna array offers strategic advantages in the next generation of mobile wireless systems since it is capable of dynamic spectrum access, directional power radiation/reception and automatic target tracking.

**Enhancement of Montana Coal to support Future Expansion Sodium Removal Technology Development**  
**Center for Advanced Mineral & Metallurgical Processing (CAMP) – Montana Tech of the University of Montana, Butte**

Montana Tech of The University of Montana (Montana Tech) and its Center for Advanced Minerals and Metallurgical Processing (CAMP) are pleased to support Montana's efforts to develop its high sodium coal reserves for use in clean coal gasification applications. The project will focus on the evaluation and development of

sodium removal and sodium recovery technologies needed for the beneficiation of high sodium coals to be used for coal gasification applications. Coal gasification, rather than direct firing of coal in boilers, is seen by many as the future of the coal industry in an increasingly carbon-conscious society. Gasification is the first step in processing coal into other forms of energy including electricity, natural gas and liquid fuels. Unfortunately, some of the most promising gasification processes cannot utilize high sodium coal. Successful execution of this project will significantly improve the marketability of southeastern Montana's high sodium coal reserves for use in clean coal gasification applications. The technology areas or knowledge developed in this project could be expanded into other sectors of the economy to increase potential and market opportunities for Montana based companies.

### **Commercialization of Low Vibration Cryocooler Technology S2 Corporation, Bozeman**

S2 Corporation has developed low vibration, low thermal fluctuation technology for cryogenic refrigerators. This technology was developed on Department of Defense Small Business Innovative Research (SBIR) programs as well as on previous MBRCT funding. Cryogenic refrigerators are used for several applications such as superconducting electronics, optical processing and low temperature research. The benefit of using cryogenic refrigerators is that they provide continuous maintenance-free cooling as low as 270 degrees below zero Celsius (3 degrees Kelvin) without requiring the use of liquid helium -- which is expensive and difficult to use. Many sensitive applications require that the cooled object also be isolated from the vibrations and thermal fluctuations caused by the cryogenic refrigerator. This is the case for S2 Corporation's holographic signal processing applications, for which this low vibration, low thermal fluctuation technology has been a critical enabling innovation. The latest funding from MBRCT will enable S2 Corporation to accomplish important and essential development that will position the company toward further commercialization of the technology for both industrial and defense related applications.

### **Commercialization of Clean Coal Production of Methane and Humic Acid: Stage I Coal Black Liquids LLC, Billings**

Coal Black Liquids LLC ("CBL") will conduct applied research required to develop and commercialize a CO<sub>2</sub> neutral biological conversion of Montana coal into methane gas for energy and humic acid products for agriculture and environmental remediation. This project is based on technology developed and patented by ARCTECH, Inc., a diversified research and development company with corporate headquarters in Chantilly, Virginia, and is uniquely suited for Montana's coal and agriculture industries, and Montana's focus on the environment. The bio-conversion technology uses naturally occurring micro-organisms (derived from wood-eating and humus-eating termites) to convert the coal. Research will include large scale Montana field trials to investigate the benefits of the organic humic acid fertilizer product in increasing crop yields, enhancing efficiency of traditional fertilizers, and producing healthy crops. Also, research will be conducted for the environmental remediation products in clean-up of Montana surface and ground water

pollution and other mitigation applications. CBL's goal is to construct a commercial size plant in Montana that, at a minimum, will produce 10 million gallons of fertilizer product, 5,000 tons of environmental remediation products, and 10,000 to 100,000 mcf of biogas.

**Preclinical Development of Low Dose Methamphetamine as a Neuroprotective Agent Following Stroke and Traumatic Brain Injury**  
**Montana Neuroscience Institute, University of Montana, Missoula**

It has been previously shown that low dose methamphetamine is highly neuroprotective when administered following stroke in both tissue culture and animal models of stroke. The goal in the current project is to establish how long after a stroke the drug can be administered and still prevent neuronal loss and damage. Traumatic brain injury and stroke share a number of similarities with regard to pathology. Therefore, this project will examine the ability of low dose methamphetamine to improve cognitive function following traumatic brain injury as well.

**Development of an ICP Etch Process for Nonlinear Optical Materials**  
**Montana Microfabrication Facility, Montana State University, Bozeman**

Montana Microfabrication Facility has recently installed a state of the art ICP plasma etcher that is used for etching insulating and conductive films. Etch processes for standard materials used in microfabrication and the semiconductor industry already exist. Equivalent etch processes are desired by local companies for nonlinear optical materials. The goal of this research is to develop etch processes that will selectively etch lithium tantalate, a material with unique optical, piezoelectric, and pyroelectric properties. These processes can then be used to create optical waveguide structures (similar to a fiber optic) that are needed to manufacture compact, efficient, visible wavelength laser systems. These laser systems are seen as enabling technology for biomedical applications such as low cost DNA sequencing and fluorescence spectroscopy.

**Developing Laboratory Applications for Inhibitors of Fungal Morphogenesis**  
**Department of Biological & Physical Sciences, Montana State University Billings, Billings**

Human fungal infections are commonly caused by *C. albicans*. This organism is a major opportunistic pathogen of immunocompromised hosts, including those undergoing chemotherapy and tissue transplants. Studies indicate that up to 90 percent of AIDS patients suffer from infections tied to *C. albicans*. Approximately 10,000 people die each year from such infections. In normal healthy humans, *C. albicans* exists in our bodies in a balanced state that does us no harm. One important aspect of infections by *C. albicans* is that it forms tubes that spread out unchecked and eventually lead to tissue destruction. This project involves using a drug (BH3I-1) to block the spread and potentially stop the infection. We are developing BH3I into a commercial laboratory reagent and exploring its potential as a novel drug to treat infections.

## **PDT Cancer Treatment Depth Efficacy Studies Using the Transplantable Rabbit VX2 Carcinoma**

**Department of Microbiology, Montana State University, Bozeman**

The greatest restriction in the current use of photodynamic therapy (PDT) for cancer treatment is the limited tissue depth at which tumor cells can be killed. The project's researchers have synthesized PDT sensitizers that can, for the first time, be activated by near infrared light. This should allow for non-invasive tumor killing at 5 to 7cm tissue depth, a significant advance over the 2-5mm depth efficacy of current FDA approved sensitizers. The core technology has been enthusiastically received by the cancer research community. To achieve the attention of practicing oncologists, however, the project needs to show that this treatment modality works on tumors in larger animals (rabbits rather than mice). This overall goal will be accomplished by showing the greatly increased depth efficacy in two situations. The first by demonstrating that there is enough depth efficacy to eliminate tumor cells from draining lymph nodes in breast cancer patients, and the second that there is enough depth efficacy to treat Small Cell Lung Cancer (SCLC). The transplantable rabbit VX2 carcinoma will be used as a model system for both cancer situations in man. SCLC is considered by many to be incurable at this time. The current grant focuses on 1.) adapting the rabbit VX2 carcinoma model at MSU to provide a model for human SCLC, and 2.) treating VX2 tumors in the lung, through the chest wall. The choice of examining depth efficacy in a model for human SCLC is based on the importance of PDT to future improvements in treating this disease.